INTEGRALLY MOULDED CLOSURE SYSTEM

The present invention relates to an integrally moulded closure system comprising a cap and neck and having tamper evident means such that, having applied the cap to the neck, the cap is prevented from being removed from the neck prior to the removal of the tamper evident means.

In WO 99/37547 there is described a one piece fitment having a reclosure cap. The fitment comprises a spout which converges upwardly and has a cylindrical external locking bead. Above the spout is an outward slanted tear band and above the tear band is a reclosure cap comprising a top, a depending skirt formed with internal interrupted beads and a plug. The tear band is connected to the spout and cap by thin horizontal tear lines. A pull tab extends outwardly or downwardly with respect to the tear band so that a consumer may conveniently grip the pull tab and pull it circumferentially around the fitment to separate the tear band from both the spout and the cap. The cap is dimensioned so that the skirt fits over the outside of the spout with the internal beads detachably locking under the locking bead. The plug seals against the inside of the spout to prevent spillage.

Thus it is known to provide a closure system comprising a cap and neck which are integrally moulded in a unitary structure. It is also known for such a structure to comprise tamper evident means since, before its removal, the tear band and reclosure cap function as a tamper evident closure for the spout. However, what is not known and what has previously not been provided is an integrally moulded closure system comprising a cap and neck and which incorporates tamper evident means in which the cap may be applied to the neck prior to the removal of the tamper evident means.

Similarly, there has been no disclosure of a closure system comprising a cap applied to a neck in which tamper evident means prevents the removal of the cap from the neck prior to the removal of the tamper evident means, the cap, neck and tamper evident means having been integrally moulded in a unitary structure.

According to a first aspect of the present invention there is provided a closure system comprising a cap, a neck and tamper evident means integrally moulded in a unitary structure, the structure allowing the application of the cap to the neck whereupon the tamper evident means prevents the cap from being removed from the neck while the tamper evident means remains intact.

Advantageously an intermediate member is joined to the neck at a first frangible connection and joined to the cap at a second frangible connection, the first frangible connection being adapted to break upon application of the cap to the neck whereupon the intermediate member co-operates with the neck and the cap to form said tamper evident means. Preferably the intermediate member comprises an annular band adapted to pass over the neck upon application of the cap to the neck and a transition member joined to the annular band, the transition member being adapted to co-operate with the neck to resist the subsequent removal of the annular band from the neck. Preferably the transition member is hinged to the annular band. For example, the annular band may be joined to the transition member by a web, the web forming a hinge permitting the transition member to flex with respect to the annular band. Advantageously the web may constitute a region of reduced thickness. Alternatively, the web may be of substantially the same thickness as the transition member but include one or more score lines to permit the transition member to flex with respect to the annular band.

Advantageously the neck is provided with a locking wall, the transition member being adapted to engage with the locking wall to resist subsequent removal of the annular band upon application of the cap to the neck. Preferably the transition member is joined to the neck at said first frangible connection, said first frangible connection being adapted to break upon application of the cap to the neck only after the act of applying the cap to the neck causes the transition member to fold inwardly of the annular band. Advantageously, upon application of the cap to the neck the transition member hinges with respect to the annular band, folding inwardly and into engagement with a locking wall provided on the neck.

Advantageously the annular band may be joined to the cap at said second frangible connection, said second frangible connection being adapted to break upon the attempted removal of the cap from the neck.

Advantageously the first and second frangible connections may lie within respective parallel planes.

Advantageously one or both of the first and second frangible connections may be formed as a line of weakness defined by a region of reduced thickness. In one preferred embodiment the transition member is tapered in the direction of the first frangible connection so that the transition member is joined to the neck in a region of reduced thickness.

Advantageously one or both of the first and second frangible connections may be formed as a plurality of frangible tabs. The plurality of frangible tabs may be circumferentially spaced with each tab being separated from an adjacent tab on either side by a pair of slits, each slit communicating at opposite ends thereof with a respective pair of apertures of increased cross-section. In this way a respective pair of apertures of increased cross-section may constitute an area of weakness disposed on either side of each of the tabs.

Advantageously, the transition member may extend from the neck to the annular band within a generally frustoconical surface.

Advantageously the transition member extends from the neck to the annular band in a direction which is inclined radially outwardly at an angle of between 22° and 32° to the axis of the closure system.

Advantageously the transition member may comprise a plurality of circumferentially spaced transition elements, the transition elements having a first circumferential dimension adjacent the annular band and a second circumferential dimension adjacent the neck, the first circumferential dimension being greater than the second circumferential dimension. Preferably, the transition elements are separated by a plurality of apertures, the apertures being arranged in groups on circumferentially opposite sides of the transition member.

Alternatively, the transition member may comprise one or more pleats or folds. In another arrangement the transition member may comprise a plurality of circumferentially spaced transition elements separated by areas of weakness or reduced thickness.

Advantageously the cap may be provided with engagement means for a repeated and releasable engagement with complimentary engagement means provided on the neck. Preferably the pair of complimentary engagement means may comprise a pair of helical thread configurations. Under such circumstances, the said configuration provided on the neck is preferably a female thread configuration.

Advantageously the pair of thread configurations are adapted so as to permit the application of the cap to the neck by means of an axially applied force whereupon the threads on the cap slide over those provided on the neck and then interengage. Preferably the treads on the cap are orientated with respect to

those on the neck in such a way that upon axial application of the cap to the neck the respective thread configurations are placed in optimal thread engagement.

Advantageously the cap may be provided with an annular plug for receipt within a bore of the neck.

Advantageously the closure system comprises a fitment for attachment to a carton or other container. Alternatively, the closure system may be integrally moulded with a container, the neck forming a neck of the container.

According to a second aspect of the present invention there is provided a method of closing a container in a tamper evident manner comprising the steps of moulding a neck of the container in one piece with a cap and tamper evident means to form a unitary structure and applying the cap to the neck in such a way that the cap is prevented from being removed from the neck while the tamper evident means remains intact.

According to a third aspect of the present invention there is provided an integrally moulded closure system comprising a cap applied to a neck, the closure system including tamper evident means integrally moulded with the cap and neck, the tamper evident means preventing removal of the cap from the neck while the tamper evident means remains intact.

The present invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is an elevational side view of a closure system embodying the present invention;

Figure 2 is a cross-sectional view of the closure system of Figure 1;

Figure 3 is a perspective view of the closure system of Figure 1;

Figure 4 is an elevational side view of the closure system of Figure 1 once the cap portion has

been applied to the neck portion;

Figure 5 is a cross-sectional view of the closure system once the cap portion has been applied to the neck portion;

Figure 6 is a perspective view of the closure system of Figure 1 once the cap portion has been applied to the neck portion; and

Figure 7 is a cross-sectional view of the closure system taking along lines VII - VII of Figure 1.

As shown in Figure 1, a closure system embodying the present invention may take the form of a fitment 10. The fitment 10 comprises a neck portion 12, a cap portion 14 and, between the two, a transition member 16 which joins the neck portion 12 to the cap portion 14.

Looking firstly at the neck portion 12, the neck portion comprises an apertured flange 18 having substantially smooth and planer upper and lower surfaces 20 and 22 respectively. Surrounding the aperture, a cylindrical wall 24 projects upwardly from the upper flange surface 20 to form the neck. Adjacent to the flange 18, the external surface of the cylindrical wall 24 is smooth before merging with a radially outwardly projecting locking wall 26 to define a shoulder. At an end of the locking wall 26 remote from the cylindrical wall 24, the locking wall 26 in turn merges with an upwardly and radially inwardly inclined surface 30 which, with the radially outwardly projecting locking wall 26, defines an annular locking bead 32. Above the annular locking bead 32, the upwardly and radially inwardly inclined surface 30 merges with a neck stretch portion 34 of slightly increased diameter compared to the cylindrical wall 24 in which is provided engagement means with which to engage complimentary engagement means provided on the cap portion 14. In the example shown, the engagement means provided on the neck stretch portion 34 takes the form of an equi-spaced, multi-lead female helical

thread configuration 36 which includes four threads or leads 36a, 36b, 36c and 36d. It will be apparent however, that the engagement means may take a number of different forms and, in particular, need not be limited to four threads or leads but may comprise one, two or three threads as appropriate. The engagement means may also comprise five or more threads if so desired. Generally speaking however, it is preferable for the configuration to comprise a plurality of threads.

In the illustrated embodiment, each thread 36a, 36b, 36c and 36d extends about 120° around the circumference of the neck stretch portion 34. Once again however, it will be understood that threads of a lesser or greater extent may also be employed. For example, each thread 36a, 36b, 36c, 36d may extend within a range from 90° to more than 360°. Preferably the helical thread configuration 36 has a fine thread density to limit the vertical float of the cap portion 14 on the neck portion 12. Thus the thread density preferably lies within a range of between 6 and 12 threads per linear inch. Most preferably of all, is a thread density of approximately 8½ threads per linear inch.

Above the helical threads 36, the neck stretch portion 34 merges with a second upwardly and radially inwardly inclined surface 38 which in turn merges with a further vertical neck stretch portion 40 before terminating in an annular rim 42.

At a radially inner edge, the annular rim 42 merges with a downwardly and radially inwardly inclined surface 44. This downwardly and radially inwardly inclined surface 44 in turn merges with a substantially smooth inner surface 46 of the cylindrical wall 24. The substantially smooth inner surface 46 flares radially outwardly adjacent the flange 18 to define a downwardly and radially outwardly inclined surface 48. Adjacent to the transition between the substantially

smooth inner surface 46 and the downwardly and radially outwardly inclined surface 48, the substantially smooth inner surface 46 is provided with a plurality of circumferentially spaced, radially inwardly projecting lugs 50.

Turning to the cap portion 14, the cap portion comprises a circular top 52 having an under surface 54. The circular top 52 merges at a radially outer edge with a downwardly and radially outwardly inclined surface 56 which in turn merges with a depending annular side wall 58 to form a downwardly extending upper skirt portion 60. The depending annular side wall 58 is provided on an inner surface 62 with complimentary engagement means for repeated and releasable engagement with the engagement means provided on the neck portion 12. As before, these engagement means may take many forms but, in the example shown, comprise an equi-spaced, multi-lead, male helical thread configuration 64 having four threads or leads 64a, 64b, 64c and 64d and a thread density of approximately 8½ threads per linear inch. In the embodiment shown each thread extends approximately 120° around the inner surface 62 of the depending annular side wall 58. However, it is to be understood that this thread length may be increased or decreased if desired. For example, each thread may extend in a range from 90° to more than 360° . Likewise, the thread density is not intended to be limited to being about 8½ threads per linear inch but, nevertheless, preferable lies within the range from about 6 to about 12 threads per linear inch. Preferably, the female thread configuration 36 on the neck portion 12 and the male thread configuration 64 on the cap portion 14 each have at least two threads and a thread density of at least 6 threads per linear inch. As shown, the male threads 64a, 64b, 64c and 64d provided on the cap portion 14 may be interrupted at

intervals along their length.

In order to facilitate the axial application of the cap portion 14 to the neck portion 12 when an axially downward force is applied to the cap portion in a direction to urge the cap portion into engagement with the neck portion, the threads of the male helical thread configuration 64 may be provided with an appropriate cross-sectional shape. For example, the threads may be formed with an asymmetric cross-section or else may be made less pronounced.

In the illustrated embodiment, the two thread configurations 36 and 64 each comprise multiple turns of thread. As a result a vertical line drawn across the thread configuration 36 on the neck portion 12 intersects two or three turns of thread depending upon the location of the line around the circumference of the neck stretch portion 34. At the same time a vertical line drawn across the thread configuration 64 on the cap portion 14 intersects one or two turns of thread depending upon the location of the line around the circumference of the depending annular side wall 58. This ensures that when the cap portion 14 is applied to the neck portion 12 there will be multiple turns of thread engagement. Of course, the total cumulative thread engagement is subject to variation and, depending upon the linear thread density, may be as little as one turn of thread engagement or more than three turns of thread engagement.

In addition to the male helical thread configuration 64, the interior of the cap portion 14 is provided with an annular plug 66 which depends from the under surface 54 of the circular top 52 and which is spaced radially inwardly of the depending annular side wall 58. The annular plug 66 is defined by respective radially inner and outer walls 68 and 70, the radially outer plug wall 70 merging at an end remote from the circular top 52 with a generally downward and radially

inwardly directed surface 72. This downwardly and radially inwardly directed surface 72 intersects the radially inner plug wall 68 and together serves to provide the annular plug 66 with a bevelled radially outer surface and a tapering cross-section. This tapering cross-section is further accentuated by the fact that, whereas the radially outer plug wall extends in a direction substantially perpendicular to the plane of the under surface 54, the radially inner plug wall 68 extends from the under surface 54 in a direction which is both downwardly and radially outwardly.

By contrast, on the exterior of the cap portion 14, the depending annular side wall 58 is provided on its outer surface with a plurality of circumferentially spaced, vertical extending ribs 74 which serve as knurls to facilitate the gripping of the cap portion 14 by a user. As is common with a number of caps, a small downwardly directed dimple 76 is formed in the centre of the circular top 52 so that any flash left after the cap portion has been moulded does not project above a plane defined by the upper surface of the circular top 52.

In addition to the foregoing features, the cap portion 14 is provided with an annular band 78 which is formed as an extension of the depending annular side wall 58 at a position remote from the circular top 52 and beneath the male helical thread configuration 64. To this end the exterior surface of the annular band 78 occupies an extension of the same cylindrical surface as that defined by the exterior surface of the depending annular side wall 58. By contrast, the inner surface 62 of the depending annular side wall 58 merges, via a short downwardly and radially outwardly inclined surface 80, with an inner band surface 82 of slightly greater inner diameter. At an end remote from the depending annular side wall 58, and therefore at an end remote from the circular top 52, the inner band

surface 82 merges with the exterior band surface via a radially outwardly directed rim 84. Both the inner and exterior surfaces of the annular band 78 are formed free of projections so as to be substantially smooth.

The annular band 78 is delimited from the depending annular side wall 58 by a plurality of arcuate slits 86 which are circumferentially spaced at intervals around the cap portion 14 and in the same horizontal plane. As a result the spacings between the arcuate slits 86 define a plurality of circumferentially spaced tabs 88 by which the annular band 78 is connected to the depending annular side wall 58. At opposite ends of each of the arcuate slits 86, the slits open out into apertures 90 of increased cross-section, thereby weakening the area on either side of each of the tabs 88.

As shown in Figure 1, the cap portion 14 is initially joined to the neck portion 12 by means of transition member 16. In the example illustrated, the transition member 16 comprises a downwardly and radially inwardly inclined frustoconical wall which is provided with a plurality of trapezium-shaped apertures 92 which serve to define therebetween a similar number of transition elements 94. Each transition element 94 lies within a frustoconical surface and has an upper circumferential dimension adjacent the annular band 78 which is greater than a lower circumferential dimension adjacent the neck portion 12. Furthermore, each transition element 94 is joined to the annular band 78 by a thin, upwardly and radially outwardly inclined web 96 which merges with the annular band 78 at the intersection of the inner surface 82 and the radially outwardly directed rim 84. At the opposite end, the inner surface of each transition element 94 is bevelled with the result that each transition element tapers to an edge 98 and it is at this edge 98 that the transition element 94 merges with the neck portion 12

at the intersection of the annular rim 42 and the downwardly and radially inwardly inclined surface 44.

The closure system herein described may be moulded in one piece with the neck portion 12 integrally formed and joined with the transition member 16 and with the transition member integrally formed and joined with the cap portion 14. However, in order to assemble the closure system an axially downwardly directed force is applied to the cap portion in a direction towards the neck portion 12. With the closure system in the orientation shown in Figure 1, it will be understood that as the cap portion 14 moves downwardly under the action of the applied force so the plurality of transition elements 94 begin to hinge about their respective tapered edges 98. At the same time the transition elements 94 also flex with respect to the annular band 78, the flexure being accommodated by the initially upwardly and radially outwardly inclined webs 96. As a result, as the cap portion 14 is urged downwardly towards the neck portion 12, the transition elements 94 fold upwards into the annular band 78 with the consequence that, as the radially outwardly directed rim 84 passes over the further vertical neck stretch portion 40 followed by the neck stretch portion 34, the transition elements 94 take up an orientation in which they extend from the annular rim 42 of the neck portion to the annular band 78 in a downward and radially outward direction.

With the cap portion 14 pressed down onto the neck portion 12 to the extent permitted by the hinging action of the transition elements 94, it will be recognised that although the annular band 78 now overlies the neck stretch portion 34, the male helical thread configuration 64 provided on the cap portion is not yet in engagement with the female helical thread configuration 36 provided on the neck portion. Continued downward movement of the cap portion 14 under

the action of the applied force causes the transition elements 94 to break away from the neck portion 12 along their respective tapering edges 98. The cap portion 14 is then free to move downwardly onto the neck portion 12 with the transition elements 94 still folded upwardly within the annular band 78. As the cap portion 14 moves downwardly so the transition elements 94 ride over the neck stretch portion 34 and the female helical thread configuration 36 until such time as the now downwardly and radially outwardly inclined webs 96 encounter the upwardly and radially inwardly inclined surface 30 of the cylindrical locking wall 24. At approximately the same time the male threads of the helical thread configuration 64 provided on the cap portion 14 encounter the second upwardly and radially inwardly inclined surface 38 which constitutes the transition between the neck stretch portion 34 and the further vertical neck stretch portion 40. Meanwhile, in the interior of the neck portion 12, the end of the annular plug 66 remote from the circular top 52 is received within the annular rim 42.

Continued downward pressure on the cap portion 14 causes the now downwardly and radially outwardly inclined webs 96 and the transition elements 94 to slide over the upwardly and radially inwardly inclined surface 30 causing the transition elements to be pressed up against the smooth inner band surface 82 and causing the annular band 78 to flex slightly radially outwardly. However, as the tapered edge 98 passes over the transition between the upwardly and radially inwardly inclined surface 30 and the radially outwardly projecting locking wall 26, so the transition elements 94 are free to flex under the restoring action of the now downwardly and radially outwardly inclined webs 96 bringing the tapered edges 98 into confronting relationship with the locking wall 26. At the same time, the slight radially outward flexing of the

annular band 78 coincides with the slight radially outward flexing of the upper skirt portion 60 as the male helical thread configuration 64 slides over and into engagement with the female helical thread configuration 36. Also at this time the annular plug 66 is received within the bore of the neck portion 12 defined by the substantially smooth inner surface 46. In so doing the generally downward and radially inwardly directed surface 72 slides along the downwardly and radially inwardly inclined surface 44 causing the annular plug 66 to flex slightly radially inwardly. Once fully received within the neck portion 12, the restoring force inherent in the resilient nature of the design and materials making up the annular plug 66 causes the radially outer plug wall 70 to be urged into sealing engagement with the substantially smooth inner surface 46. Thus, in the assembled condition, the interaction between the annular plug 66 and the substantially smooth inner surface 46 constitutes a primary seal.

A secondary seal is provided in the assembled condition by the receipt of the annular rim 42 within the annular recess defined between the radially outer plug wall 70 and the downwardly and radially outwardly inclined surface 56 of the cap portion 14. In order to accommodate the annular rim 42 the radially outwardly inclined surface 56 is forced to flex slightly radially outwardly with the result that the restoring force holds the radially outwardly inclined surface in sealing engagement with the annular edge defined by the intersection of the annular rim 42 and the further vertical neck stretch portion 40.

With the closure system in the assembled condition the fitment 10 may be applied to a paperboard or other carton in the conventional manner. In this regard it will be noted that the flared opening to the neck portion 12 defined by the downwardly and radially

outwardly inclined surface 48 facilitates the insertion of a spud of a manipulation tool. At the same time the provision of the plurality of circumferentially spaced, radially inwardly projecting lugs 50 facilitate the retention of the fitment on the spud. Since the apertured flange 18 has substantially smooth and planar upper and lower surfaces 20 and 22, the fitment 10 may be bonded either to the outside or to the inside of a carton panel as desired. However, in another arrangement, the neck portion 12 may be provided with one or more additional projections which cooperate with the apertured flange 18 to retain the fitment 10 in a specific orientation with respect to the carton panel to which the fitment is to be attached.

Once the fitment 10 has been applied to a carton, the fitment provides that carton with a closure that can be repeatedly opened and closed as desired and which offers excellent sealing and re-sealing characteristics. In addition, the fitment also provides a tamper evident capability to alert a consumer should the contents of the carton have been compromised prior to initial opening. This tamper evident capability is provided in the form of a tear-band which must first be separated from the cap portion 14 before the cap portion can be removed from the neck portion 12. If a consumer finds that the tear-band has been separated from the cap portion 14 before the fitment 10 has first been opened by them then it is possible that the contents of the carton may have been tampered with or may have become adversely affected in some other way. The tamper evident capability of the fitment functions as follows.

In the assembled condition the cap portion 14 is prevented from being removed from the neck portion 12 in an axial direction by the interengagement of the male and female helical thread configurations 64 and 36 and by the engagement of the tapered edges 98 with the

annular locking bead 32. In order to remove the cap portion therefore, a user is required to rotate the cap portion 14 with respect to the neck portion 12. This causes the threads of the male thread configuration 36 to rise up the grooves of the female thread configuration 36 bringing the tapered edges 98 more firmly into engagement with the locking wall 26. Continued upward movement of the cap portion 14 with respect to the neck portion 12 is resisted by the transition elements 94 with the result that the upward force exerted by a user in unscrewing the cap portion is applied to the circumferentially spaced tabs 88 which serve to connect the annular band 78 to the depending annular sidewall 58. The provision of apertures 90 of increased cross-section on either side of each of the tabs 88 ensures that the tabs will fracture as a user continues to unscrew the cap portion 14 and long before any damage is sustained to the now downwardly and radially outwardly inclined webs 96. Once the tabs 88 have been broken the cap portion 14 may be removed and the contents dispensed from the carton. The cap portion 14 may be reapplied and subsequently removed from the neck portion 12 as often as it is desired.

In the example shown, once the tabs 88 have been fractured, the tear-band (in the form of annular band 78 and transition elements 94) remains in place on the neck portion 12 beneath the locking wall 26. However, it will be appreciated that in order to provide the tear-band with a drop-down capability which may more easily alert a consumer to potential tampering, all that is required is to elongate the portion of the cylindrical wall 24 between the apertured flange 18 and the radially outwardly projecting locking wall 26.

It will be apparent to those skilled in the art that the closure system of the present invention is not limited to the embodiment described and that numerous

variations are possible. Having said, in order to facilitate the manufacturing process it has been found advantageous to limit the extent to which the internal diameter of the annular band 78 exceeds the internal diameter of the substantially smooth inner surface 46. Although the annular band 78 clearly has to pass over the neck stretch portion 34, if the difference between these two internal diameters becomes too large it becomes difficult to extract that part of the mould tool responsible for the internal surface features (the core) through the restricted opening defined by the neck portion 12 and transition member 16. For this reason, although it is possible to provide the neck portion 12 with a male thread configuration with which to engage a complimentary configuration provided on the cap portion 14, nonetheless a female thread configuration is preferred. A female thread configuration 36 on the neck portion 12 also provides the advantage that there are no radial protrusions which might otherwise foul the annular band 78 as the cap portion 14 is applied to the neck portion 12.

In order to facilitate the extraction of the core it has also been found preferable for the transition elements 94 to be inclined radially outwardly at an angle of between 22° and 32° to the vertical, and most preferably, at an angle of 27° to the vertical. At the same time, in the specific embodiment shown, the vertical distance between the radially outwardly directed rim 84 and the annular rim 42 is preferably 3.5mm while the tapered edge 98 preferably has a radial dimension of between 0.16mm and 0.10mm. Elsewhere along their length the transition elements 94 preferably have a dimension at right angles to the angle of inclination of 0.5mm.

Whilst the trapezium-shaped apertures 92 may be arranged at intervals around the transition member 16, for ease of moulding the apertures are preferably

arranged in groups of three on circumferentially opposite sides of the closure system. In this way the trapezium-shaped apertures 92 may be formed using slides that open and close at right angles to the male and female halves of the mould tool. In such an arrangement, each group of three trapezium-shaped apertures 92 are preferably symmetrical about a vertical centre line with the central trapezium-shaped aperture having an upper circumferential dimension adjacent the annular band 78 of 2mm and the two mutually inclined sides of the aperture subtending an angle of 30°. The trapezium-shaped apertures on either side are preferably spaced 6.2mm from the centre line and arranged so as to have an upper circumferential dimension adjacent the annular band 78 of 1mm while the mutually inclined sides of the apertures subtend an angle of 25°. In order to facilitate the folding upwards of the transition elements 94 into the annular band 78 as the cap portion 14 is pushed onto the neck portion 12, the two trapezium-shaped apertures 92 spaced on either side of the central aperture within each group of three are preferably not themselves symmetrical. Rather, the inclined edge of the two side apertures closest to the central trapezium-shaped aperture preferably subtends an angle of 20° with respect to the centre line. In this way each transition element 94 has an upper circumferential dimension adjacent the annular band 78 which is greater than its lower circumferential dimension adjacent the neck portion 12.

By contrast to the transition member 16, the annular band 78 has a vertical dimension from the short downwardly and radially outwardly inclined surface 80 to the radially outwardly directed rim 84 of 4.55mm with the distance from the short downwardly and radially outwardly inclined surface 80 to the arcuate slits 86 accounting for 0.5mm of that vertical

dimension. In order to facilitate the removal of the core and to ensure that the tabs 88 are reliably fractured upon initial unscrewing of the cap portion 14, the slits 86 preferably have a vertical dimension of 0.25mm and open out into apertures 90 having a vertical dimension of 0.85mm. This leaves the annular band 78 with a vertical dimension of 3.2mm between the apertures 90 and the radially outwardly directed rim 84.

As with the trapezium-shaped apertures 92, the arcuate slits 86 are preferably formed using slides that open and close at right angles to the male and female halves of the mould tool. The arcuate slits 86 are therefore preferably formed so as to have no undercuts in the direction of movement of the slides. This means that the surfaces joining the circumferential outer surface of the annular band 78 to the inner band surface 82 do not extend radially but rather have the configuration shown in Figure 7 in which the surfaces on either side of one of the tabs 88 subtend an angle of 135° while those at opposite ends of one of the arcuate slits 86 subtend an angle of 92°. In order to ensure that the tabs 88 fracture reliably they are preferably circumferentially spaced at intervals of 45° and have a radial dimension of 0.25mm. The apertures 90 on either side of each of the tabs 88 are preferably dimensioned so that an arcuate slit 86 joining two such apertures has a circumferential dimension of 7.0mm.

One of the advantages of the closure assembly herein described is that the cap portion 14 is held in fixed relationship with the neck portion 12 prior to application of the cap portion to the neck portion. As a result it is possible, with suitable alignment of the thread configurations 36 and 64, to ensure that once the cap portion 14 has been applied to the neck portion 12 the threads are optimally engaged. This in turn

means that no subsequent tightening of the cap portion 14 is required thereby simplifying the capping process in comparison with the processes of the prior art. At the same time, the optimization of the thread engagement means that the closure system may utilise the minimum thread length commensurate with the sealing properties required, thereby enabling savings in both cap and neck height. This in turn translates into a saving of plastics material which bears a direct relation to the cost of manufacture of the closure system. The optimization of the thread engagement also serves to eliminate any vertical float of the cap portion 14 on the neck portion 12 which would otherwise have to be allowed for in the vertical distance between the annular locking bead 32 and the apertured flange 18. Because this vertical float can be eliminated, the closure system can be designed so that the transition elements 94 engage with the locking bead 32 almost immediately upon unscrewing of the cap portion 14, thereby rendering the closure system more secure against unwanted tampering as well as cheaper to manufacture.

Although the present invention has been described in relation to a fitment for attachment to a carton, it will be appreciated by those skilled in the art that the invention is not so limited and that the closure assembly may be formed integrally with a container if so desired.